AMENDMENTS TO THE CLAIMS

1. (Currently amended) An estimation method for estimating illumination on a sensor capable of capturing non-destructively a plurality of image samples during an exposure period, said method comprising the steps of:

measuring an illumination indication from said sensor, said measuring occurs ~~a multiplicity of~~ two or more times at intervals during said exposure period, ~~thereby~~ producing a multiplicity of measurements; and

determining, based on an optimal weighted averaging process, an estimated illumination on said sensor from said multiplicity of measurements.

2. (Original) The estimation method of claim 1, wherein said sensor is a photodiode and said illumination indication is a charge accumulated from photocurrent produced by said photodiode.

3. (Original) The estimation method of claim 2, wherein said measuring step occurring non-destructively and said charge accumulating over said exposure period.

4. (Original) The estimation method of claim 1, wherein said determining step including statistical signal processing of said multiplicity of measurements, said signal processing being based on a noise model selected from a fixed pattern noise model, a reset noise model, a shot noise model and a read noise model.

5. (Original) The estimation method of claim 1, wherein said determining step including statistical signal processing of said multiplicity of measurements, said signal processing being based on maximizing a likelihood of accuracy of said estimated illumination.

6. (Original) The estimation method of claim 1, wherein said determining step including statistical signal processing of said multiplicity of measurements, said signal processing being based on minimizing an error of said estimated illumination.

7. (Original) The estimation method of claim 1, wherein said determining step including statistical signal processing of said multiplicity of measurements, said signal processing being based on minimizing a linear mean square error of said estimated illumination.

8. (Original) The estimation method of claim 1, wherein said sensor is configured in a sensor array, a pixel sensor in a digital camera, a pixel sensor in a video camera, a pixel sensor in a stereo digital camera or a pixel sensor in a stereo video camera.

9. (Currently amended) An estimation method for non-recursively estimating an optimal illumination on a sensor capable of capturing non-destructively a plurality of image samples during an exposure period, said method comprising the steps of:

measuring an illumination indication from said sensor;

storing said illumination indication, wherein said measuring and storing steps occur ~~a multiplicity of~~ two or more times during said exposure period, ~~thereby~~ collecting non-destructively a multiplicity of measurements; and

performing a non-recursive optimal illumination estimation on said sensor from all or essentially all of said collected multiplicity of measurements.

10. (Original) The estimation method of claim 9, wherein said sensor is a photodiode and said illumination indication is a charge accumulated from photocurrent produced by said photodiode.

11. (Original) The estimation method of claim 10, wherein said measuring step occurring non-destructively and said charge accumulating over said exposure period.

12. (Original) The estimation method of claim 9, wherein said determining step including statistical signal processing of said multiplicity of measurements, said

signal processing being based on maximizing a likelihood of accuracy of said estimated illumination.

13. (Original) The estimation method of claim 9, wherein said determining step further comprising statistical signal processing of said multiplicity of measurements, said signal processing being based on minimizing an error of said estimated illumination.

14. (Original) The estimation method of claim 9, wherein said determining step further comprising statistical signal processing of said multiplicity of measurements, said signal processing being based on minimizing a linear mean square error of said estimated illumination.

15. (Original) The estimation method of claim 9, wherein said sensor is configured in a sensor array, a pixel sensor in a digital camera, a pixel sensor in a video camera, a pixel sensor in a stereo digital camera or a pixel sensor in a stereo video camera.

16. (Currently amended) An estimation method for recursively estimating an optimal illumination on a sensor capable of capturing non-destructively a plurality of image samples during an exposure period, said method comprising the steps of:

measuring an illumination indication from said sensor, said measuring occurs ~~a multiplicity of~~ two or more times at intervals during said exposure period, ~~thereby~~ producing a multiplicity of measurements; and

determining an estimated illumination on said sensor from all or essentially all of said multiplicity of measurements non-destructively captured before motion/saturation, said determining step occurring recursively over said multiplicity of measurements and including statistical signal processing of said multiplicity of measurements, said signal processing being based on a noise model selected from a fixed pattern noise model, a reset noise model, a shot noise model and a read noise model.

17. (Currently amended) The estimation method of claim 16 further comprising a step of maintaining a plurality of parameters during said measuring step, said plurality of parameters comprising:

said estimated illumination;

means for ~~weighting~~ weighing a particular one of said multiplicity of measurements;

means for indicating variance between said particular one of said multiplicity of measurements and said multiplicity of measurements; and

means for indicating overall variance of said multiplicity of measurements.

18. (Original) The estimation method of claim 16 further comprising a step of maintaining a plurality of parameters during said measuring step, said plurality of parameters comprising:

said estimated illumination;

a weighting coefficient applied to a difference between a present one of said multiplicity of measurements and said estimated illumination corresponding to a previous one of said multiplicity of measurements;

a mean square error of said estimated illumination; and

a covariance of said estimated illumination with said present one of said multiplicity of measurements.

19. (Original) The estimation method of claim 16, wherein said sensor is a photodiode and said illumination indication is a charge accumulated from photocurrent produced by said photodiode.

20. (Original) The estimation method of claim 16, wherein said measuring step occurring non-destructively and said charge accumulating over said exposure period.

21. (Original) The estimation method of claim 16, wherein said determining step including statistical signal processing of said multiplicity of measurements, said signal processing being based on maximizing a likelihood of accuracy of said estimated illumination.

22. (Original) The estimation method of claim 16, wherein said determining step further comprising statistical signal processing of said multiplicity of measurements, said signal processing being based on minimizing an error of said estimated illumination.

23. (Original) The estimation method of claim 16, wherein said determining step further comprising statistical signal processing of said multiplicity of measurements, said signal processing being based on minimizing a linear mean square error of said estimated illumination.

24. (Original) The estimation method of claim 16, wherein said sensor is configured in a sensor array, a pixel sensor in a digital camera, a pixel sensor in a video camera, a pixel sensor in a stereo digital camera or a pixel sensor in a stereo video camera.

25. (Currently amended) An apparatus configured to estimate illumination on a sensor during an exposure period, said apparatus comprising:

a sampling means configured to measure an illumination indication~~,~~ at ~~a multiplicity of~~ two or more time intervals during said exposure period~~, an illumination indication from a sensor~~, and ~~configured~~ to ~~thereby~~ produce a multiplicity of measurements thereof;

a linear mean square estimation means configured to derive optimal weights from said multiplicity of measurements; and

an estimation means configured to determine, based on weighted averaging utilizing said optimal weights, an estimated illumination on said sensor from said multiplicity of measurements.

26. (Original) The apparatus of claim 25, wherein said sensor is implemented in a sensor array, a pixel sensor in a single chip imaging device, a pixel sensor in a digital camera, a pixel sensor in a video camera, a pixel sensor in a stereo digital camera or a pixel sensor in a stereo video camera.

27. (Original) The apparatus of claim 25, wherein said sensor is a photodiode and said illumination indication is a charge accumulated from photocurrent produced by said photodiode.

28. (Original) The apparatus of claim 27, wherein said sampling means operates non-destructively and said charge accumulates over said exposure period.

29. (Original) The apparatus of claim 25, wherein said estimation means being configured to perform statistical signal processing of said multiplicity of measurements, said signal processing being based on a noise model selected from a fixed pattern noise model, a reset noise model, a shot noise model and a read noise model.

30. (Original) The apparatus of claim 25, wherein said estimation means being configured to perform statistical signal processing of said multiplicity of measurements, said signal processing being based on maximizing a likelihood of accuracy of said estimated illumination.

31. (Original) The apparatus of claim 25, wherein said estimation means being configured to perform statistical signal processing of said multiplicity of measurements, said signal processing being based on minimizing an error of said estimated illumination.

32. (Original) The apparatus of claim 25, wherein said estimation means being configured to perform statistical signal processing of said multiplicity of measurements, said signal processing being based on minimizing a linear mean square error of said estimated illumination.

33. (Currently amended) An apparatus configured to estimate illumination on a sensor during an exposure period, said apparatus comprising:

a sampling means configured to measure, at a multiplicity of time intervals during said exposure period, an illumination indication from ~~a~~ said sensor, and configured to ~~thereby~~ produce a multiplicity of measurements; and

an estimation means configured to determine an estimated illumination on said sensor from said multiplicity of measurements, said estimation means being configured to compute recursively over said multiplicity of measurements and to maintain recursively a plurality of parameters over said multiplicity of measurements, said plurality of parameters comprising:

said estimated illumination;

means for ~~weighting~~ weighing a particular one of said multiplicity of measurements;

means for indicating variance between said particular one of said multiplicity of measurements and said multiplicity of measurements; and

means for indicating overall variance of said multiplicity of measurements.

34. (Currently amended) An apparatus configured to estimate illumination on a sensor during an exposure period, said apparatus comprising:

a sampling means configured to measure, at a multiplicity of time intervals during said exposure period, an illumination indication from ~~a~~ said sensor, and configured to ~~thereby~~ produce a multiplicity of measurements; and

an estimation means configured to determine an estimated illumination on said sensor from said multiplicity of measurements, wherein said estimation means being configured to perform statistical signal processing of said multiplicity of measurements, said signal processing being based on a noise model selected from a fixed pattern noise model, a reset noise model, a shot noise model and a read noise model, and wherein said estimation means being configured to compute recursively over said multiplicity of measurements and to maintain recursively a plurality of parameters over said multiplicity of measurements, said plurality of parameters comprising:

said estimated illumination;

a weighting coefficient applied to a difference between a present one of said multiplicity of measurements and said estimated illumination corresponding to a previous one of said multiplicity of measurements;

a mean square error of said estimated illumination; and

a covariance of said estimated illumination with said present one of said multiplicity of measurements.

35. (Currently amended) An apparatus configured to estimate illumination on a sensor during an exposure period for simultaneously reducing noise and improving dynamic range at low illumination end, where said sensor is configured in a complementary metal oxide semiconductor (CMOS) image sensor system capable of capturing multiple image samples during said exposure period, said apparatus comprising:

means for measuring, at ~~a multiplicity of~~ two or more intervals during said exposure period, actual photocurrent from said sensor, said means for measuring ~~thereby~~ producing a multiplicity of photocurrent measurements; and

means for estimating optimal photocurrent on said sensor from said multiplicity of measurements, utilizing all or essentially all photocurrent measurements non-destructively captured before motion/saturation.

36. (Previously presented) The estimation method of claim 9, wherein said determining step comprising statistical signal processing of said multiplicity of measurements, said signal processing being based on a noise model selected from a fixed pattern noise model, a reset noise model, a shot noise model and a read noise model.